

# **November 1997**

## **Preliminary Data Summary**

by      Field Research Facility

U.S. Army Corps of Engineers  
Waterways Experiment Station  
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# Preface

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This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

**Data from these reports are now available via the World Wide Web at**  
**<http://www.frf.usace.army.mil>**

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and suggestions are welcome.

# Introduction

## 1

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The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (252)261-6840 ext.222 ([c.baron@cerc.wes.army.mil](mailto:c.baron@cerc.wes.army.mil)).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).

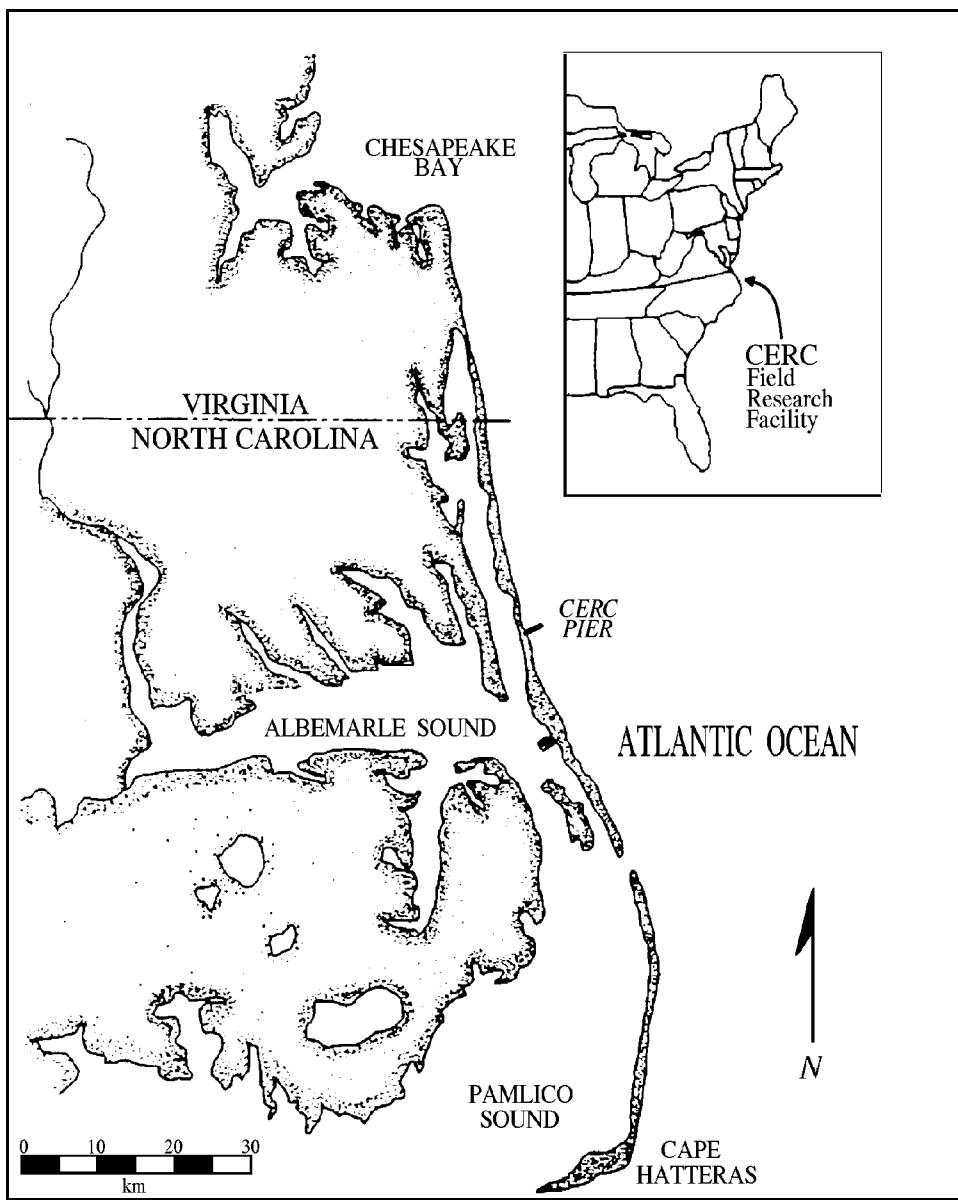


Figure 1. FRF Location Map

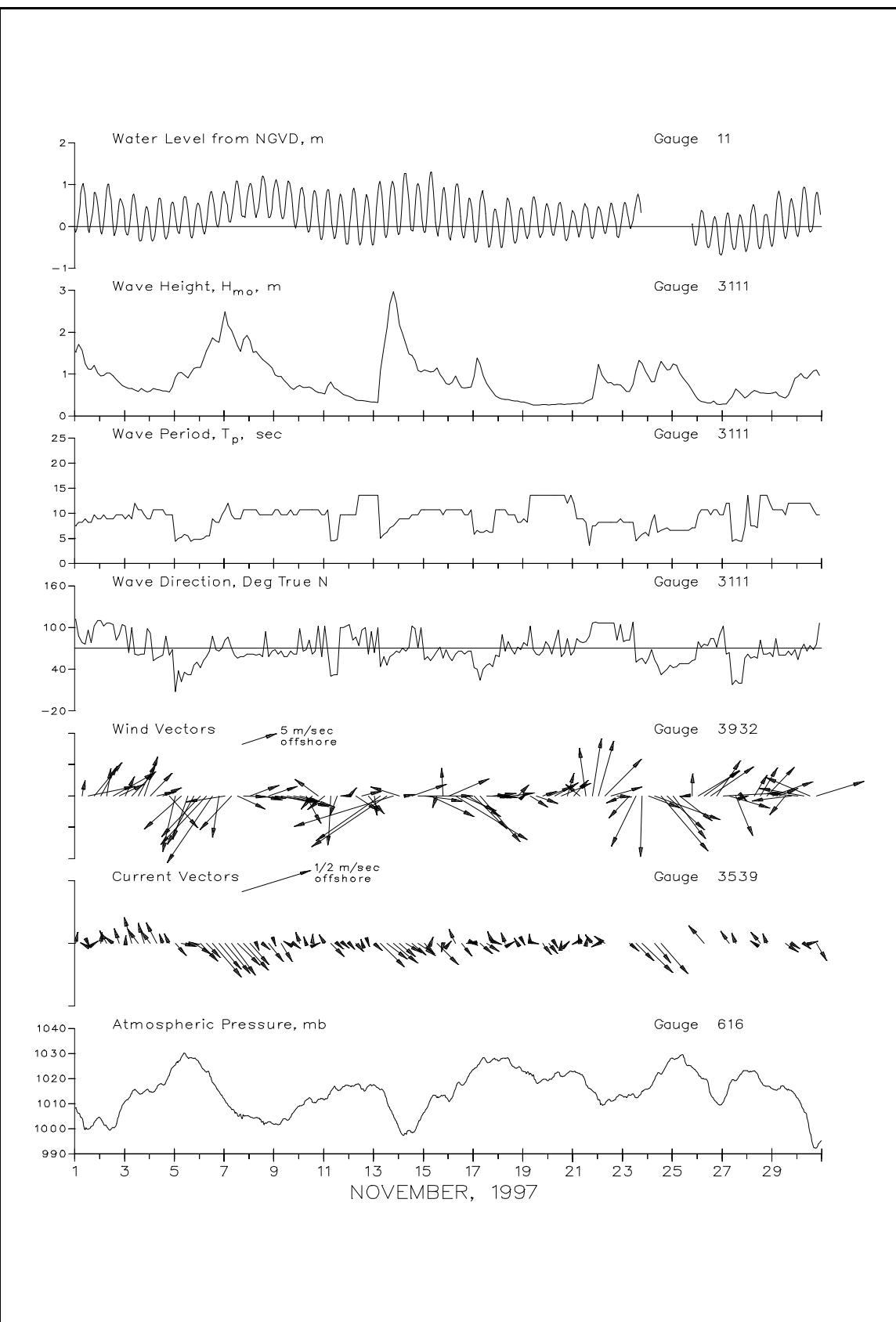


Figure 2. Month at a Glance

**Table 1**  
**Instrument Status/Data Availability**

		November 1997																																		
		Day of the month																																		
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0					
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	/	*	*	*	*	*	*				
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	*	*	*	*	*		
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	/	/	/	/	/		
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																													
Data Collected		*	= All	/	= Partial	-	= None																													
Visual Observations		*	= Complete	/	= Partial	-	= None																													

**Table 2**  
**Gauge Locations**

Gauge*	Description	* Latitude	* Longitude	* FRF Coordinates	* Gauge Depth	* Water Depth
ID *		* Degrees N	* Degrees W	* CrossshoreT Longshore*	NGVD, m	* NGVD, m
		*	*	*	m	*
616	* Atmospheric Pressure*	36 10' 57.03"	* 75 45' 5.50"	* 11.60	* 569.00	* -----
3932	* Anemometer	* 36 11' 1.23"	* 75 44' 43.07"	* 585.20	* 517.30	* 19.50
641	* Pressure Gauge	* 36 10' 57.71"	* 75 44' 56.23"	* 239.11	* 516.64	* -1.64
625	* Baylor Staff	* 36 11' 1.04"	* 75 44' 43.72"	* 568.00	* 516.64	* Surface
3111	* 8 Meter Array North	* 36 11' 19.14"	* 75 44' 36.41"	* 915.23	* 990.16	* -7.50
	* 8 Meter Array South	* 36 11' 11.28"	* 75 44' 33.28"	* 914.20	* 735.37	* -7.42
	* 8 Meter Array East	* 36 11' 13.70"	* 75 44' 32.56"	* 954.51	* 800.58	* -7.62
	* 8 Meter Array West	* 36 11' 12.48"	* 75 44' 37.11"	* 834.66	* 800.37	* -6.98
111	* Pressure Gauge in center of 8 M Array	* 36 11' 14.06"	* 75 44' 34.39"	* 914.43	* 825.52	* -7.76
630	* Waverider Buoy	* 36 10' 5.10"	* 75 41' 59.30"	* 3934.96	* -2400.81	* Surface
3539	* Current Meter	* 36 11' 23.57"	* 75 44' 9.12"	* 1605.80	* 907.60	* -11.60
11	* NOAA Tide Gauge	* 36 11' 1.25"	* 75 44' 42.60"	* 596.49	* 514.20	* Surface
R	R	R	R	R	R	R

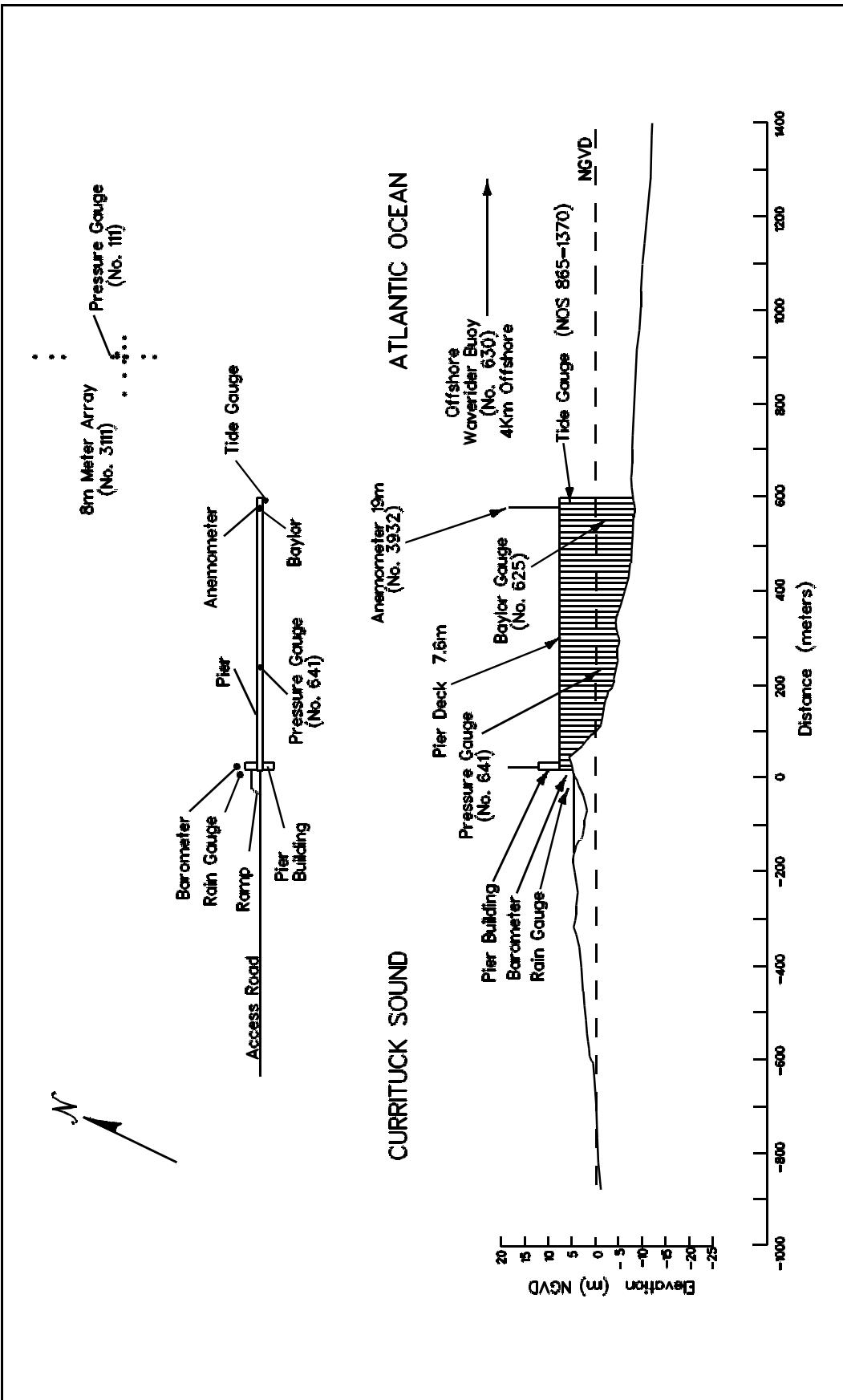


Figure 3. Instrument Locations, Elevations From NGVD

# Meteorological Data

## 2

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A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

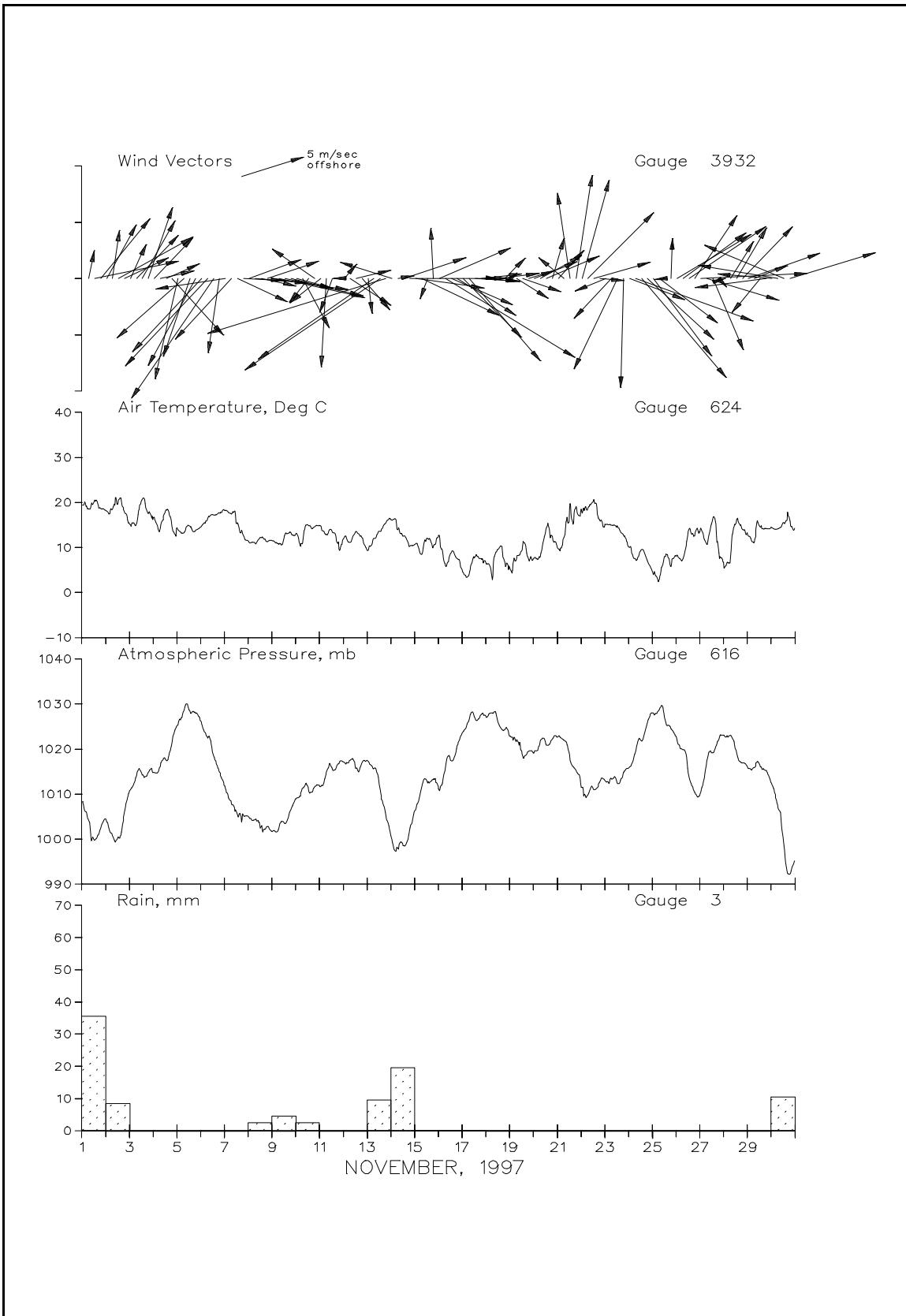


Figure 4. Meteorological Monthly Summary

**Table 3**  
**Meteorological Data**

Nov 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	10	1	19.4	1008.3	0
	700	2	1	18.5	1004.2	36
	1300	7	256	20.6	999.9	0
	1900	6	215	18.7	1002.5	0
2	100	5	205	18.1	1003.9	0
	700	4	186	18.4	1000.8	9
	1300	7	237	20.5	1000.5	0
	1900	4	241	17.8	1006.1	0
3	100	3	201	15.0	1011.0	0
	700	5	220	15.3	1014.2	0
	1300	6	206	20.6	1014.3	0
	1900	7	196	17.6	1014.8	0
4	100	5	219	16.7	1014.8	0
	700	3	255	14.3	1016.2	0
	1300	3	242	18.5	1017.5	0
	1900	6	322	14.7	1021.3	0
5	100	9	11	14.0	1025.3	0
	700	7	44	13.3	1028.6	0
	1300	7	16	14.7	1028.3	0
	1900	9	25	13.9	1028.0	0
6	100	8	39	14.9	1025.6	0
	700	10	39	16.5	1022.5	0
	1300	12	30	17.2	1018.5	0
	1900	7	7	17.7	1014.9	0
7	100	5	79	18.3	1011.3	0
	700	7	38	17.5	1007.9	0
	1300	4	1	15.5	1005.4	0
	1900	3	273	12.6	1005.4	0
8	100	4	247	11.1	1004.8	0
	700	4	275	10.9	1004.4	2
	1300	3	1	12.2	1002.8	0
	1900	4	1	11.3	1002.9	0
9	100	6	1	11.4	1001.9	0
	700	7	284	10.7	1002.5	4
	1300	6	284	13.0	1003.5	0
	1900	3	1	13.3	1006.6	0
10	100	3	288	13.1	1009.1	0
	700	5	335	11.1	1011.3	2
	1300	3	35	14.9	1010.7	0
	1900	4	128	14.6	1011.8	0

**Table 3**  
**Meteorological Data (continued)**

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Nov 1997		
				Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	3	47	14.8	1011.7	0
	700	8	3	12.9	1015.0	0
	1300	3	17	13.4	1015.5	0
	1900	0		11.2	1016.7	0
12	100	2	216	12.4	1017.1	0
	700	4	307	11.1	1017.6	0
	1300	3	254	13.6	1015.7	0
	1900	3	322	12.2	1017.1	0
13	100	3	354	9.4	1017.3	0
	700	11	51	12.0	1015.7	10
	1300	13	51	13.6	1010.9	0
	1900	14	70	15.5	1005.4	0
14	100	4	110	16.1	1000.0	0
	700	1	258	14.0	997.9	20
	1300	5	1	12.6	998.6	0
	1900	7	269	10.3	1002.1	0
15	100	5	1	10.8	1006.5	0
	700	7	298	8.4	1011.6	0
	1300	2	1	12.0	1012.4	0
	1900	4	177	10.2	1013.2	0
16	100	6	243	12.7	1010.8	0
	700	12	1	5.9	1016.0	0
	1300	5	1	8.9	1017.4	0
	1900	6	306	7.6	1020.8	0
17	100	7	319	4.4	1023.9	0
	700	9	323	4.1	1026.6	0
	1300	3	273	8.0	1026.8	0
	1900	3	262	7.5	1027.8	0
18	100	3	1	6.4	1027.1	0
	700	0		3.6	1027.9	0
	1300	3	261	9.8	1025.5	0
	1900	2	1	6.7	1024.3	0
19	100	1	224	4.9	1022.9	0
	700	3	306	7.5	1022.1	0
	1300	3	1	10.4	1018.5	0
	1900	2	250	7.3	1019.6	0
20	100	4	245	7.8	1019.4	0
	700	4	237	8.0	1021.9	0
	1300	4	243	14.4	1020.9	0
	1900	4	194	12.5	1022.2	0

**Table 3**  
**Meteorological Data (concluded)**

Nov 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	3	218	9.6	1022.9	0
	700	3	1	12.3	1021.9	0
	1300	8	172	19.8	1017.5	0
	1900	9	187	19.1	1015.2	0
22	100	9	193	17.6	1011.5	0
	700	8	220	18.6	1009.8	0
	1300	5	251	20.7	1011.0	0
	1900	2	276	16.0	1012.9	0
23	100	3	64	15.1	1012.8	0
	700	5	39	14.9	1013.4	0
	1300	9	22	14.8	1012.4	0
	1900	10	1	12.7	1014.9	0
24	100	5	294	10.1	1016.1	0
	700	10	292	7.4	1019.5	0
	1300	11	323	9.6	1021.8	0
	1900	7	316	7.1	1025.8	0
25	100	8	327	4.0	1028.0	0
	700	6	311	2.9	1028.9	0
	1300	1	83	8.0	1026.2	0
	1900	4	1	5.8	1024.5	0
26	100	7	235	8.3	1022.0	0
	700	6	229	7.6	1019.8	0
	1300	7	231	14.1	1013.8	0
	1900	6	209	12.6	1010.5	0
27	100	8	266	14.3	1010.5	0
	700	6	1	10.8	1017.5	0
	1300	7	339	16.5	1019.3	0
	1900	1	320	8.8	1022.3	0
28	100	0		5.5	1022.9	0
	700	4	208	8.0	1023.1	0
	1300	5	207	16.2	1019.2	0
	1900	6	219	14.0	1017.0	0
29	100	6	247	12.6	1015.7	0
	700	3	245	11.1	1016.0	0
	1300	4	35	14.6	1016.1	0
	1900	5	81	14.3	1015.2	0
30	100	4	1	14.4	1012.2	0
	700	6	100	14.2	1006.9	10
	1300	7	115	15.5	998.5	0
	1900	7	250	15.8	992.4	0
		Resultant		Mean	Mean	Total
		2	294	12.7	1014.7	93

# Wave Data

## 3

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Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4**  
**Wave Data**

Nov 1997										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.47	10.3	0.73	9.5	1.53	7.6	112	1.63	6.7
	0700	0.94	7.6	1.40	7.6	1.57	8.2	78	1.65	7.7
	1300	0.59	8.3	1.09	8.9	1.12	8.2	96	1.44	9.1
	1900	0.74	9.2	1.12	9.9	1.21	9.8	102	1.42	9.1
2	0100	0.55	9.2	0.83	9.9	0.95	8.9	110	1.19	9.1
	0700	0.67	9.2	0.77	9.2	1.03	8.9	106	1.12	10.1
	1300	0.50	8.6	0.70	9.5	0.95	8.9	104	1.17	10.1
	1900	0.49	9.5	0.60	9.5	0.79	9.8	90	0.96	9.1
3	0100	0.38	9.2	0.53	9.5	0.69	8.9	102	0.80	11.2
	0700	0.40	8.3	0.48	8.3	0.66	8.9	100	0.76	8.4
	1300	0.30	9.9	0.44	11.7	0.59	10.8	60	0.70	11.8
	1900	0.34	10.3	0.52	9.5	0.61	9.8	62	0.73	10.1
4	0100	0.26	7.8	0.47	8.1	0.60	8.9	92	0.68	9.1
	0700	0.32	11.2	0.47	11.7	0.64	10.8	56	0.66	11.8
	1300	0.31	11.2	0.47	10.7	0.60	10.8	60	0.67	11.2
	1900	0.29	9.5	0.48	9.5	0.58	9.8	60	0.72	10.1
5	0100	0.57	4.2	0.84	9.2	0.92	4.4	8	1.02	4.2
	0700	0.76	5.3	0.96	4.8	1.04	5.3	22	1.26	5.1
	1300	0.70	5.9	0.87	5.4	0.91	5.6	32	1.09	5.6
	1900	0.69	4.7	1.03	4.5	1.14	4.8	46	1.23	4.6
6	0100	0.72	4.8	1.05	5.1	1.16	4.8	42	1.39	5.1
	0700	0.88	5.2	1.40	5.1	1.55	5.6	58	1.75	5.3
	1300	1.05	5.3	1.55	6.5	1.87	8.9	88	2.12	5.3
	1900	0.97	5.3	1.59	8.6	1.76	8.2	66	1.99	7.2
7	0100	1.62	11.2	2.07	11.2	2.49	10.8	82	2.57	10.1
	0700	1.31	10.7	1.79	10.7	2.05	9.8	70	2.07	9.1
	1300	1.15	9.2	1.36	9.2	1.68	8.9	56	1.92	10.1
	1900	1.19	9.9	1.52	9.9	1.84	10.8	58	1.66	10.1
8	0100	1.26	11.2	1.52	11.2	1.79	10.8	62	1.75	10.6
	0700	1.04	10.7	1.29	10.3	1.54	10.8	60	1.68	11.2
	1300	0.99	9.9	1.05	10.7	1.36	9.8	58	1.45	10.1
	1900	0.77	10.3	1.08	9.5	1.23	9.8	58	1.27	10.6
9	0100	0.74	9.9	0.88	9.5	0.97	10.8	68	1.22	9.1
	0700	0.71	8.9	0.80	9.9	0.95	9.8	66	1.12	10.6
	1300	0.61	9.2	0.60	9.9	0.78	9.8	58	0.99	10.1
	1900	0.43	9.2	0.58	9.5	0.64	9.8	62	0.79	10.6
10	0100	0.55	6.1	0.54	9.2	0.73	10.8	98	0.87	10.1
	0700	0.50	5.5	0.60	10.7	0.68	10.8	68	0.78	10.6
	1300	0.51	5.3	0.51	9.5	0.65	10.8	62	0.77	10.6
	1900	0.43	5.1	0.57	10.7	0.56	10.8	102	0.71	5.6

**Table 4**  
**Wave Data (continued)**

Nov 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
11	0100	0.38	5.0	0.46	10.3	0.53	9.8	102	0.62	10.1	
	0700	0.58	4.3	0.73	4.5	0.81	4.6	30	1.00	4.4	
	1300	0.48	4.7	0.58	9.9	0.64	4.8	32	0.83	4.8	
	1900	0.36	5.0	0.42	9.9	0.50	9.8	100	0.62	10.6	
12	0100	0.31	15.1	0.40	9.5	0.46	9.8	104	0.53	10.1	
	0700	0.26	15.1	0.35	15.1	0.38	9.8	86	0.47	14.3	
	1300	0.18	14.3	0.33	14.3	0.37	13.6	96	0.38	10.1	
	1900	0.21	14.3	0.28	14.3	0.34	13.6	62	0.34	12.6	
13	0100	0.20	13.5	0.36	13.5	0.33	13.6	64	0.40	14.3	
	0700	0.56	3.9	0.63	3.6	1.08	5.0	44	0.69	3.1	
	1300	1.09	6.5	1.73	6.1	2.08	6.2	46	1.92	5.9	
	1900	1.60	7.6	2.44	7.8	2.97	7.6	62	3.15	7.2	
14	0100	1.18	8.3	1.86	8.6	2.17	8.9	64	2.68	8.4	
	0700	1.22	8.9	1.46	8.9	1.71	8.9	66	2.05	8.4	
	1300	0.87	10.3	1.27	9.9	1.45	9.8	102	1.79	10.1	
	1900	0.82	9.5	1.00	9.2	1.09	9.8	70	1.33	9.1	
15	0100	0.74	11.2	0.92	11.2	1.10	10.8	54	1.22	10.6	
	0700	0.83	11.2	0.88	9.9	1.05	10.8	52	1.31	11.2	
	1300	0.79	10.7	0.97	10.7	1.15	10.8	66	1.14	10.6	
	1900	0.71	9.9	0.78	10.3	0.89	9.8	56	1.10	10.6	
16	0100	0.36	11.2	0.62	10.7	0.75	10.8	58	0.77	10.1	
	0700	0.63	10.7	0.76	11.2	0.95	10.8	62	1.16	10.1	
	1300	0.43	6.0	0.63	10.3	0.67	10.8	66	0.90	10.6	
	1900	0.49	6.1	0.51	9.9	0.68	9.8	66	0.90	10.6	
17	0100	0.73	5.7	0.82	4.9	0.94	5.9	42	1.07	5.9	
	0700	1.16	6.5	1.14	6.5	1.23	6.2	24	1.71	6.7	
	1300	0.72	5.7	0.72	5.9	0.78	6.6	46	1.04	6.7	
	1900	0.42	6.1	0.49	6.6	0.57	6.2	44	0.79	6.3	
18	0100	0.27	4.9	0.38	15.1	0.43	10.8	58	0.48	11.2	
	0700	0.23	15.1	0.34	14.3	0.40	10.8	66	0.44	10.6	
	1300	0.21	15.1	0.31	10.3	0.37	9.8	68	0.39	10.6	
	1900	0.20	11.2	0.37	8.9	0.36	8.2	72	0.35	9.1	
19	0100	0.20	5.1	0.25	8.1	0.33	8.9	78	0.36	14.3	
	0700	0.17	13.5	0.25	8.3	0.29	13.6	102	0.33	10.6	
	1300	0.17	13.5	0.23	13.5	0.25	13.6	62	0.32	13.4	
	1900	0.16	14.3	0.32	14.3	0.27	13.6	66	0.28	13.4	
20	0100	0.17	13.5	0.22	13.5	0.26	13.6	74	0.30	12.6	
	0700	0.14	12.9	0.31	13.5	0.28	13.6	78	0.28	12.6	
	1300	0.15	12.9	0.25	12.9	0.28	13.6	58	0.29	14.3	
	1900	0.14	12.9	0.26	12.9	0.28	12.0	84	0.30	12.6	

**Table 4**  
**Wave Data (concluded)**

Nov 1997													
Day	Hour	641			625			3111			630		
		Pressure Gauge Hmo,m	Gauge Tp,sec	Baylor Gauge Hmo,m	Gauge Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec	Waverider Hmo,m	Tp,sec	
21	0100	0.16	12.9	0.23	12.9	0.29	12.0	66	0.34	13.4			
	0700	0.14	13.5	0.32	9.2	0.30	8.9	80	0.31	9.1			
	1300	0.22	2.7			0.34	8.2	80	0.42	8.4			
	1900	0.22	3.4			0.42	7.6	106	0.47	3.8			
22	0100	0.86	8.1			1.23	8.2	106	1.45	7.7			
	0700	0.54	8.6			0.88	8.2	106	1.13	7.7			
	1300	0.50	8.1			0.80	8.2	106	1.00	8.4			
	1900	0.41	8.3			0.76	8.2	82	0.83	9.1			
23	0100	0.42	8.6			0.66	8.2	80	0.82	8.4			
	0700	0.34	8.3			0.58	8.2	82	0.68	8.4			
	1300	0.73	4.2	inoperative		1.09	4.6	50	1.14	7.7			
	1900	1.05	5.7			1.26	5.9	56	1.56	5.6			
24	0100	0.69	5.5			0.94	5.6	56	1.19	5.9			
	0700	0.53	5.4			0.83	9.8	54	0.97	10.1			
	1300	0.92	6.5			1.30	6.6	32	1.28	3.7			
	1900	0.96	6.6			1.10	7.1	40					
25	0100	1.13	6.8			1.24	6.6	42	inoperative				
	0700	0.94	6.1			1.03	6.6	48					
	1300	0.68	6.1	0.72	6.6	0.92	6.6	0	0.93	6.7			
	1900	0.44	6.6	0.58	7.8	0.61	7.1	52	0.75	7.7			
26	0100	0.19	10.3	0.46	9.5	0.38	9.8	80	0.57	7.2			
	0700	0.16	10.7	0.31	9.9	0.33	10.8	76	0.50	10.1			
	1300	0.13	9.9	0.27	10.3	0.31	9.8	84	0.43	10.1			
	1900	0.17	10.3	0.34	10.3	0.29	10.8	72	0.47	10.6			
27	0100	0.14	9.5	0.24	9.9	0.28	9.8	102	0.42	12.6			
	0700	0.23	4.5	0.27	11.2	0.38	12.0	64	0.56	4.1			
	1300	0.46	4.2	0.61	4.5	0.64	4.8	24	0.79	4.1			
	1900	0.38	4.4	0.48	4.5	0.51	4.4	20	0.68	7.2			
28	0100	0.27	5.6	0.41	12.9	0.48	13.6	62	0.57	7.7			
	0700	0.38	8.3	0.48	7.8	0.61	7.6	58	0.67	7.2			
	1300	0.24	15.1	0.51	7.2	0.54	13.6	82	0.73	6.7			
	1900	0.29	12.9	0.41	13.5	0.54	13.6	62	0.59	13.4			
29	0100	0.23	10.7	0.42	10.7	0.54	10.8	58	0.58	10.6			
	0700	0.30	10.7	0.39	10.7	0.49	10.8	60	0.48	11.2			
	1300	0.21	10.7	0.40	10.3	0.43	9.8	60	0.48	11.2			
	1900	0.41	12.2	0.53	12.9	0.66	12.0	60	0.69	13.4			
30	0100	0.61	4.5	0.85	11.7	0.95	12.0	54	0.98	12.6			
	0700	0.63	11.7	0.81	12.9	0.93	12.0	76	0.98	12.6			
	1300	0.55	10.3	0.90	11.7	0.97	12.0	74	1.11	11.8			
	1900	0.79	6.6	0.94	6.5	1.10	9.8	76	1.35	6.3			
Mean		0.56	8.7	0.73	9.7	0.86	9.3	67	0.98	9.2			
Std dev		0.34	3.1	0.45	2.6	0.51	2.4	22	0.55	2.7			

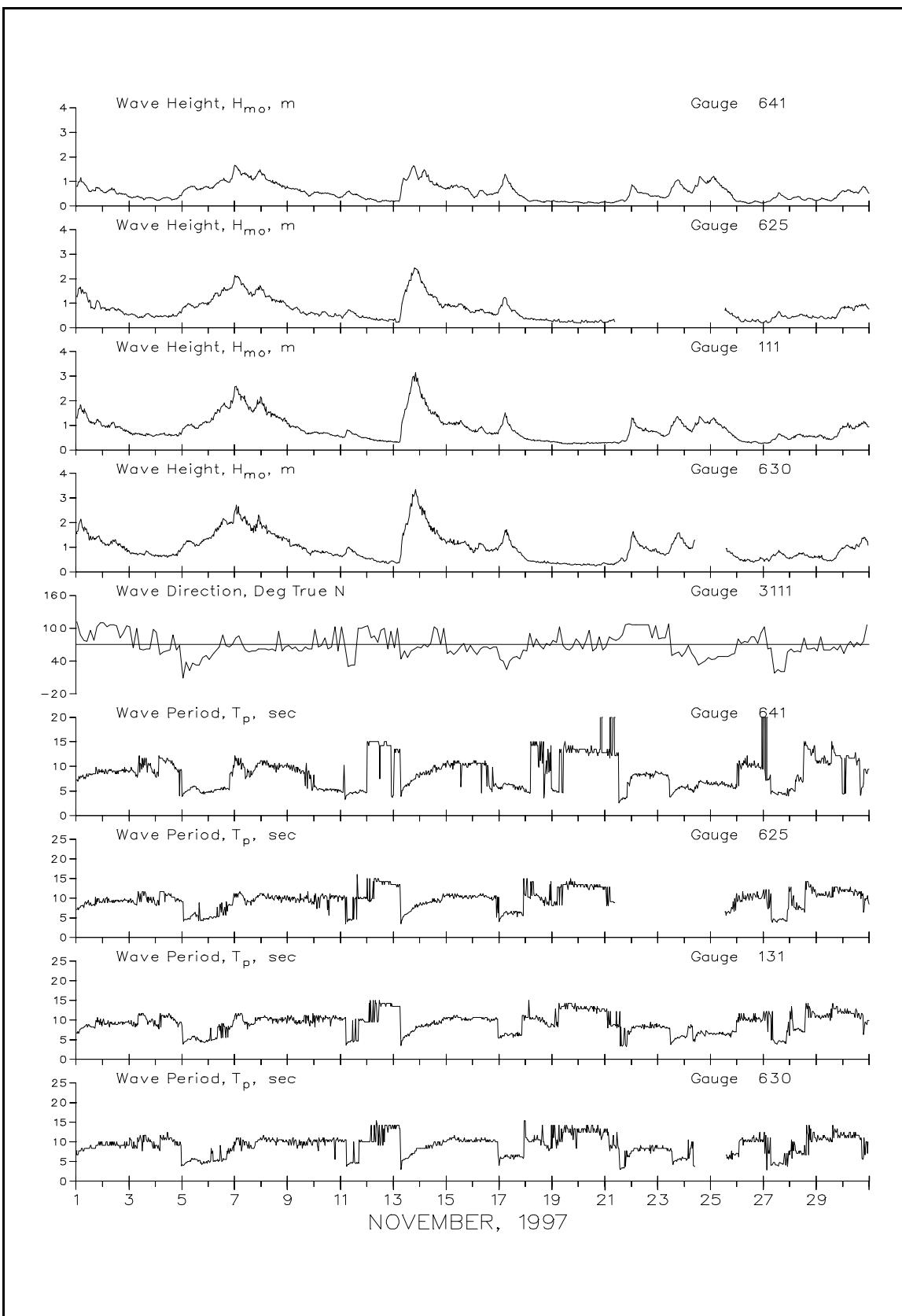


Figure 5. Wave Heights and Periods

# Current Data

## 4

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Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

**Table 5**  
**Current Meter Data - Gauge 3539**

NOVEMBER 1997																	
	Cross Long				Cross Long				Cross Long								
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	-3	-7	9	8	11	100	1	-7	8	331	21	100	1	0	1	242
	700	1	0	1	304		700	-4	13	14	139		700	0	-6	7	351
	1300	0	3	3	156		1300	-2	6	6	136		1300	-2	-3	5	10
	1900	-2	0	3	51		1900	-1	5	5	133		1900	2	-7	8	324
2	100	-3	-7	9	7	12	100	-1	6	6	142	22	100	6	1	6	240
	700	1	-10	11	334		700	-2	8	8	140		700	5	-7	9	309
	1300	4	-6	8	313		1300	0	-2	3	342		1300				
	1900	0	-11	12	344		1900	0	2	2	163		1900				
3	100	-1	-5	6	1	13	100	-2	7	7	136	23	100				
	700	-1	-21	22	346		700	-8	23	25	139		700	-3	8	8	135
	1300	3	-12	13	329		1300	-8	16	19	132		1300	-6	17	18	139
	1900	-1	-16	17	345		1900	-9	20	23	133		1900	-11	29	31	138
4	100	3	-10	12	326	14	100	-6	13	15	133	24	100				
	700	1	-17	18	336		700	-6	10	13	124		700	-4	18	19	144
	1300	0	-7	8	342		1300	-5	12	13	134		1300	-8	29	30	142
	1900	0	-7	8	337		1900	-7	13	15	129		1900				
5	100	-3	11	12	142	15	100	-3	10	10	140	25	100				
	700	-7	5	10	102		700	-2	-3	5	19		700				
	1300	-6	3	8	94		1300	-7	21	22	139		1300				
	1900	-7	12	15	126		1900	3	6	7	187		1900				
6	100	-6	17	19	139	16	100	-1	0	2	37	26	100				
	700	-4	14	14	140		700	0	-11	12	338		700	5	-16	18	323
	1300	-8	32	33	143		1300	-2	12	12	145		1300				
	1900	-6	24	26	144		1900	1	0	1	262		1900				
7	100	-7	28	29	144	17	100	-1	2	3	120	27	100				
	700	-6	29	30	147		700	-4	10	11	135		700	2	-10	12	329
	1300	-7	21	23	138		1300	-5	9	11	127		1300	0	-7	8	342
	1900	-8	25	27	142		1900	0	-9	10	339		1900				
8	100	-5	20	21	142	18	100	0	1	2	111	28	100				
	700	0	6	6	160		700	0	-8	9	341		700	2	-2	4	309
	1300	-2	6	7	133		1300	-1	0	2	56		1300	3	-10	11	325
	1900	-3	17	17	145		1900	1	-4	5	332		1900	0	-7	8	342
9	100	0	2	2	162	19	100	0	1	1	155	29	100				
	700	-1	16	16	152		700	-1	-6	7	355		700				
	1300	2	-1	3	304		1300	0	1	2	102		1300	-5	9	11	128
	1900	-2	5	6	129		1900	-1	10	11	147		1900	-3	6	7	126
10	100	0	-8	9	343	20	100	-2	10	10	143	30	100				
	700	0	-4	5	345		700	0	4	4	148		700	-2	6	6	133
	1300	-2	-6	7	4		1300	0	0	0			1300	-4	0	5	73
	1900	0	0	0	0		1900	-1	0	2	42		1900	-1	15	15	152

KEY:

+cross-shore = offshore, cm/sec  
 -cross-shore = onshore, cm/sec  
 +longshore = south, cm/sec  
 -longshore = north, cm/sec  
 Speed = Resultant speed, cm/sec  
 Dir = Resultant direction, degrees true north

**Table 6**  
**Visually Observed Current Data**

Nov 1997												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-2	20	20	166	-9	-87	88	334	South	40	N	
2	9	-30	32	357	-20	-51	55	318	South	47	N	
3	no observation				-15	-51	53	323	no observation			
4	10	-38	39	354	2	-23	24	346	South	25	S	
5	-18	20	27	202	-43	61	74	195	North	21	S	
6	-7	47	47	169	-43	36	56	210	North	33	S	
7	-15	44	46	179	-27	20	33	213	North	48	N	
8	15	28	32	131	-32	29	43	208	North	33	S	
9	20	44	48	136	-26	44	51	191	North	39	S	
10	-2	8	9	177	-28	23	37	210	North	33	S	
11	-5	47	47	166	-32	36	48	202	North	55	S	
12	5	18	19	146	10	-34	35	357	South	25	S	
13	-30	41	51	197	-78	87	117	202	North	33	S	
14	30	41	51	123	-23	38	44	191	North	37	S	
15	11	24	27	136	-21	47	51	184	North	25	S	
16	10	41	42	146	-10	32	33	177	North	29	S	
17	2	47	47	157	-18	61	64	177	North	48	S	
18	3	-17	17	349	2	-4	5	7	South	20	S	
19	34	7	34	81	3	13	13	149	North	13	S	
20	10	-25	27	2	7	-9	11	17	South	11	N	
21	-5	-30	31	331	3	-7	8	4	South	9	S	
22	14	-23	26	11	-10	-102	102	334	South	18	N	
23	-12	47	48	174	-18	41	45	184	North	37	S	
24	9	61	62	151	-20	68	71	177	North	27	S	
25	20	51	55	138	-37	41	55	202	North	15	S	
26	13	-22	25	11	9	-10	14	22	South	34	N	
27	15	10	18	104	41	10	42	70	North	20	S	
28	4	-14	15	357	30	-20	37	36	South	34	N	
29	0	30	30	160	15	10	18	70	North	96	S	
30	-13	-15	20	298	-20	10	23	250	South	30	S	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

# Visual Observations

## 5

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Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

**Table 7**  
**Visual Observations**

Day	Time	Wave Approach Angle at Pier End (degrees from True N)		Surf Zone Width, m	Water Characteristics at Pier End		
		Primary	Secondary		Temp., C	Density g/cc	Secchi Vis., m
1	0705	85	45	96	17.8	1.0238	0.3
2	0755	80	130	67	18.3	1.0240	0.6
3	1245	no observations		49			
4	0810	115		40	18.3	1.0248	0.9
5	0752	20		85	18.3	1.0246	1.8
6	0727	20	80	80	17.2	1.0246	0.6
7	0828	35	90	104	16.1	1.0222	0.6
8	0710	35		82	15.0	1.0220	0.6
9	0716	20		52	14.4	1.0230	0.3
10	0918	20		52	15.0	1.0232	0.6
11	0830	25		60	14.4	1.0234	0.6
12	0830	30		30	14.7	1.0234	0.9
13	0818	20	80	71	13.9	1.0228	0.3
14	0928	30	90	95	13.9	1.0214	0.9
15	0859	20		63	13.3	1.0214	0.9
16	1021	10		43	13.3	1.0232	0.6
17	0827	10		63	12.5	1.0240	0.3
18	0838	80		16	12.2	1.0240	0.6
19	0905	10		8	12.2	1.0242	1.2
20	0910	80		18	11.4	1.0240	1.2
21	0925	95		37	11.9	1.0240	1.5
22	0900	120		47	16.4	1.0250	0.9
23	1120	20		59	14.4	1.0250	0.6
24	0815	20		68	12.8	1.0246	0.9
25	0826	20	65	68	10.6	1.0232	0.9
26	0745	70		64	12.2	1.0240	1.2
27	0915	70	20	61	12.8	1.0254	1.5
28	0900	50		67	12.8	1.0255	0.9
29	1000	70	160	49	13.3	1.0251	0.6
30	0945	110		61	13.3	1.0250	2.1

# Water Levels

## 6

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Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

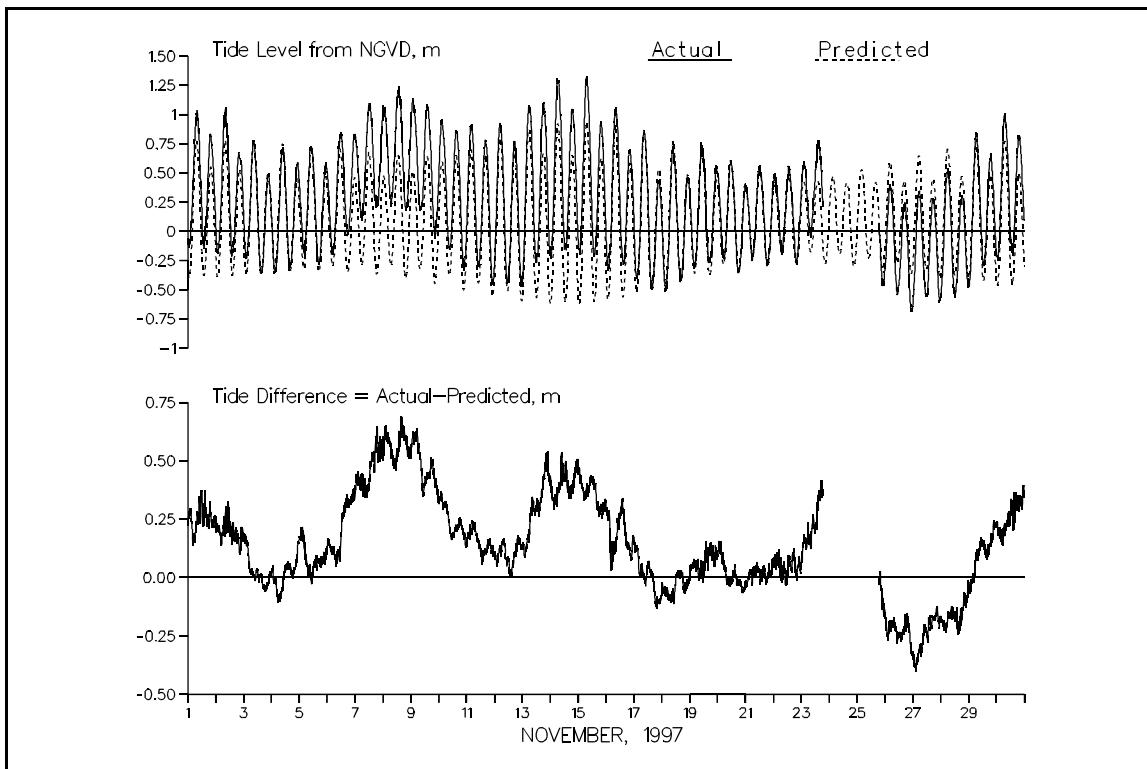


Figure 6. Water Level Variation

**Table 8**  
**Water Levels, m NGVD**

NOV 1997 Tide Levels																		
Day	High			Low			Mean	Range	High			Low			Mean		Range	
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day	Time	m	m	m
1	0754	1.04	1	0100	-0.14		0.46	1.18	16	0806	1.06	16	0148	-0.34	0.36	1.40		
1	1948	0.83	1	1412	-0.15		0.36	0.99	16	2012	0.70	16	1448	-0.29	0.21	0.99		
2	0830	1.06	2	0200	-0.19		0.41	1.25	17	0842	0.87	17	0242	-0.41	0.22	1.27		
2	1948	0.68	2	1400	-0.22		0.26	0.89	17	2136	0.43	17	1518	-0.50	-0.03	0.93		
3	0836	0.78	3	0236	-0.23		0.26	1.02	18	0936	0.72	18	0318	-0.52	0.10	1.24		
3	2112	0.49	3	1518	-0.36		0.06	0.85	18	2224	0.46	18	1630	-0.43	0.02	0.89		
4	0936	0.72	4	0242	-0.36		0.17	1.08	19	1006	0.76	19	0406	-0.32	0.21	1.07		
4	2236	0.59	4	1554	-0.31		0.14	0.90	19	2248	0.57	19	1648	-0.27	0.14	0.84		
5	1006	0.73	5	0412	-0.19		0.27	0.92	20	1136	0.61	20	0518	-0.24	0.18	0.85		
5	2242	0.59	5	1642	-0.29		0.15	0.88	21	0018	0.40	20	1812	-0.36	0.03	0.75		
6	1148	0.85	6	0454	-0.20		0.34	1.05	21	1154	0.56	21	0548	-0.25	0.17	0.82		
7	0000	0.83	6	1730	-0.04		0.42	0.87	22	0118	0.50	21	1830	-0.30	0.11	0.80		
7	1212	1.10	7	0554	0.09		0.61	1.00	22	1254	0.56	22	0730	-0.20	0.18	0.76		
8	0024	1.07	7	1812	0.20		0.63	0.88	23	0236	0.60	22	2006	-0.28	0.18	0.88		
8	1348	1.24	8	0700	0.21		0.73	1.03	23	1500	0.78	23	0754	-0.05	0.39	0.83		
9	0154	1.14	8	1948	0.18		0.65	0.96	24	312		23	2036	No data this cycle				
9	1418	1.09	9	0754	0.18		0.61	0.91	24	1506		24	900	No data this cycle				
10	0242	0.95	9	2054	-0.06		0.45	1.01	25	354		24	2112	No data this cycle				
10	1518	0.87	10	0924	-0.16		0.35	1.03	25	1554		25	1000	No data this cycle				
11	0348	0.91	10	2142	-0.34		0.30	1.25	26	0418	0.40	25	2154	-0.47	-0.04	0.87		
11	1600	0.78	11	1012	-0.30		0.23	1.08	26	1706	0.25	26	1024	-0.55	-0.15	0.79		
12	0430	0.93	11	2236	-0.46		0.24	1.39	27	0542	0.35	26	2236	-0.69	-0.18	1.03		
12	1730	0.77	12	1100	-0.45		0.16	1.22	27	1700	0.28	27	1148	-0.56	-0.14	0.85		
13	0600	1.07	12	2324	-0.47		0.31	1.55	28	0624	0.54	27	2254	-0.61	-0.04	1.15		
13	1818	1.10	13	1148	-0.27		0.42	1.38	28	1806	0.31	28	1206	-0.56	-0.11	0.88		
14	0612	1.30	14	0036	-0.23		0.55	1.54	29	0612	0.85	28	2318	-0.49	0.16	1.33		
14	1842	1.05	14	1336	-0.16		0.45	1.21	29	1900	0.67	29	1306	-0.30	0.18	0.97		
15	0730	1.33	15	0118	-0.20		0.56	1.53	30	0712	1.01	30	0106	-0.25	0.36	1.25		
15	1930	0.94	15	1400	-0.22		0.36	1.16	30	1912	0.82	30	1418	-0.21	0.33	1.03		

# Bathymetry

## 7

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A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in November and the survey(s) in October on profile line 188, located 517 m south of the pier.

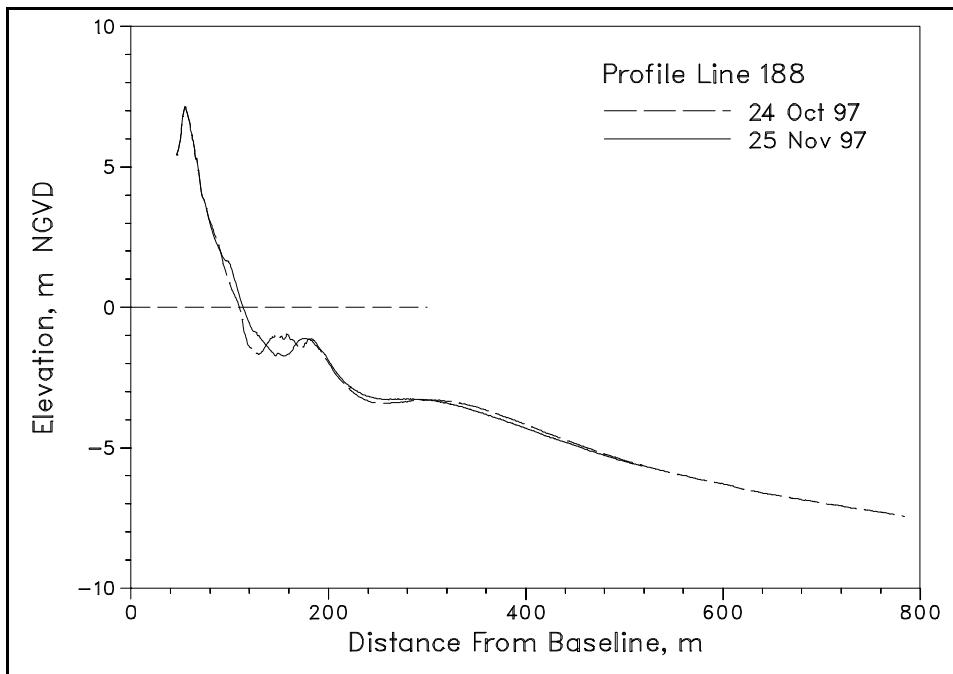


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1997. Cross-hatched areas indicate changes to the annual envelope which occurred in December.

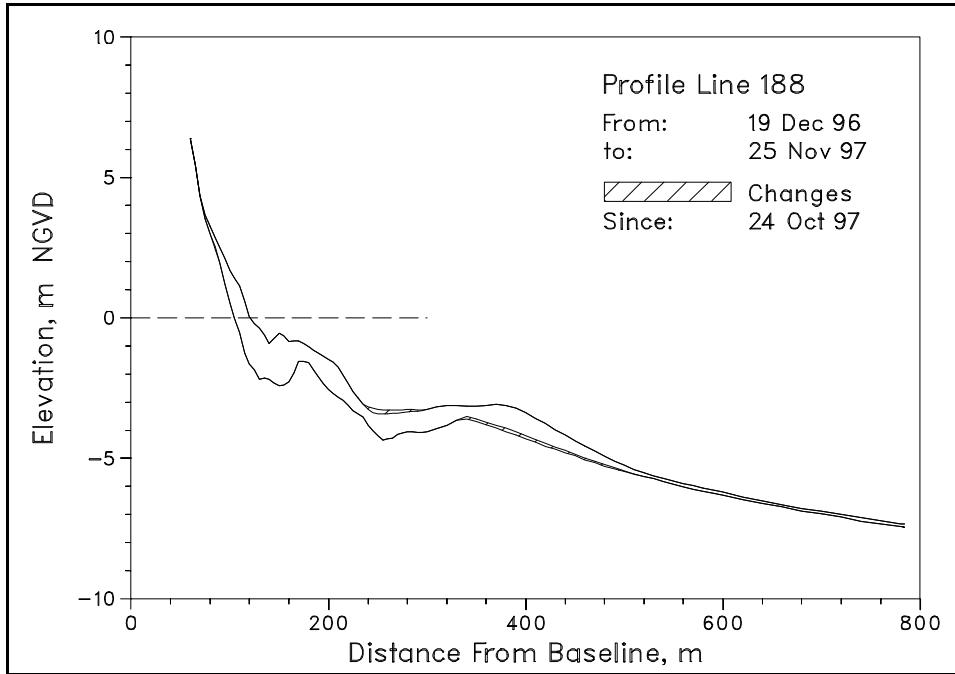
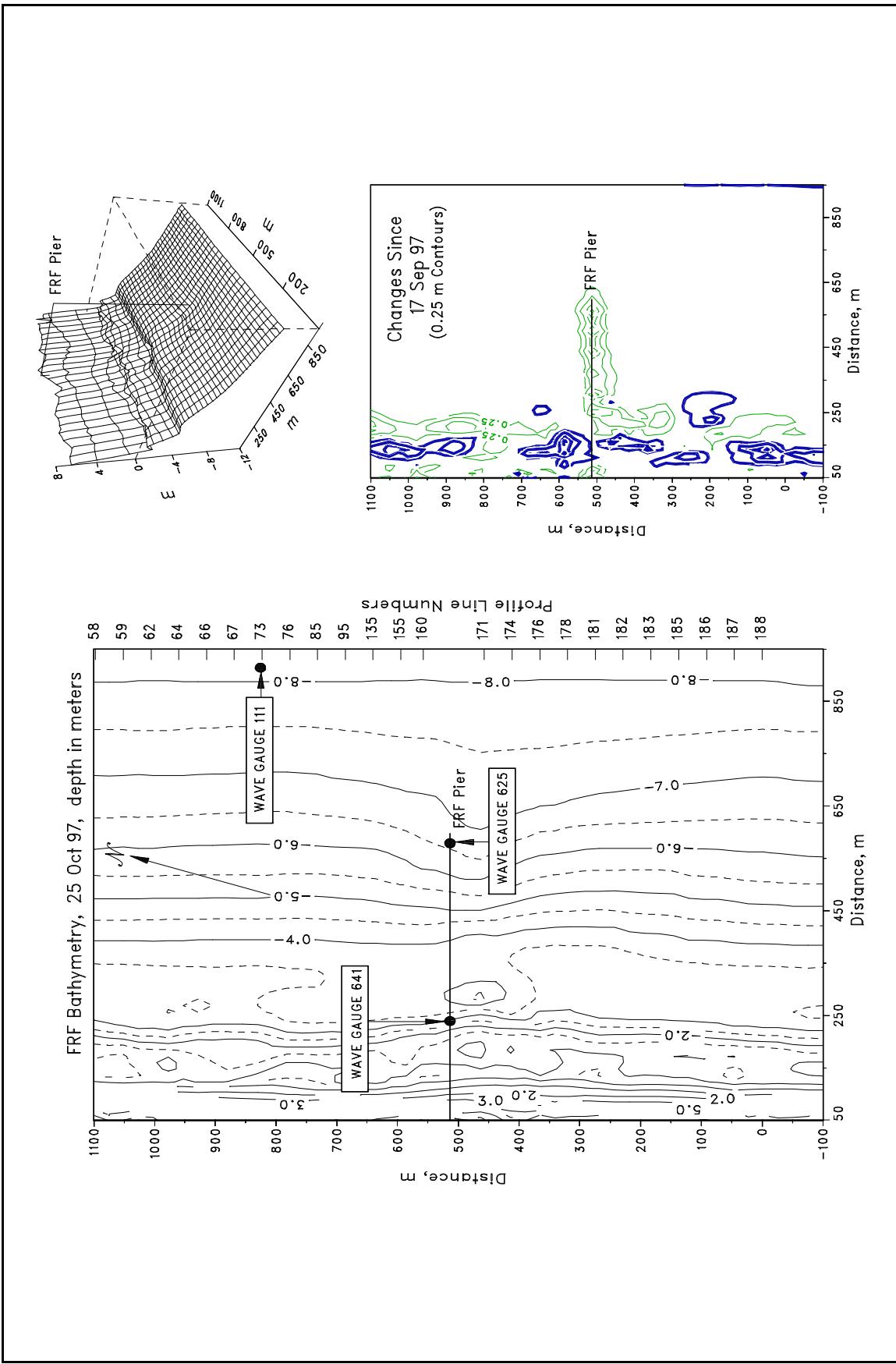


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 25 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no Bathymetric survey done in November due to SandyDuck instrument removal. Figure 9 is included for reference only.



# Special Events

## 8

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A. Storm Data Collection. The following list identifies times when the wave height  $H_{mo}$  at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
6 Nov (2308)	7 Nov (0400)
13 Nov (1600)	14 Nov (0016)

B. Storm Synopsis.

6-7 Nov Winds were associated with a low pressure system that approached from the west. Maximum onshore winds (NE) reached 6 m/s at 0134 EST on 7 November. The maximum  $H_{mo}$ , at gauge 625, reached 2.1 m ( $T_p=11.1$  s) at 0016 EST on 7 November. There was 2 mm of precipitation.

13 Nov Northeasterly winds were funneled between a high pressure system over New York State and a low pressure system just offshore of South Carolina. Maximum onshore winds (NE) reached 15 m/s at 1900 EST on 13 November. The minimum atmospheric pressure was 1001 mb. The maximum  $H_{mo}$ , at gauge 625, reached 2.4 m ( $T_p=8.3$  s) at 1900 EST on 13 November. There was 30 mm of precipitation.